

THE PLANT DISEASE REPORTER

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CROPS RESEARCH DIVISION

AGRICULTURAL RESEARCH SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE

PHYSIOLOGIC RACES OF PUCCINIA GRAMINIS
IN THE UNITED STATES IN 1958

Supplement 258

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Crops Protection Research Branch

Plant Industry Station, Beltsville, Maryland

PHYSIOLOGIC RACES OF PUCCINIA GRAMINIS IN THE UNITED STATES IN 1958^{1, 2}

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Summary

From 566 uredial collections of wheat stem rust (*Puccinia graminis* var. *tritici*), 27 races and subraces⁶ were identified among 775 isolates. Race 56 comprised 29 percent of the isolates, a slight decrease from the previous year; race 11 comprised 23 percent, an increase that was influenced by the unusually large number of isolates from the Pacific Northwest; race 15B, 18 percent, a slight decrease; the 17-29 race group⁷ (with race 29) increased to 16 percent; and race 38 comprised 5 percent. These races totaled 91 percent of the isolates. In the spring-wheat area, including Minnesota, South Dakota, and North Dakota, race 15B was identified in 45 percent of the isolates, whereas the 17-29 group was found only on screening varieties in nurseries in this area.

Variants of several races or subraces were isolated that may prove important in breeding programs involving Frontana crosses and others. Race 34 also was isolated for the first time from the widely grown Selkirk wheat.

Among 138 uredial and aecial isolates of wheat stem rust from the Pacific Northwest, 15 races and subraces were identified, six of which were not found elsewhere in the United States. Race 11 was most prevalent among uredial isolates, comprising 91 percent in Oregon, 78 percent in Idaho, and 68 percent in Washington.

Seven races and one subrace of oat stem rust (*P. graminis* var. *avenae*) were identified among 286 uredial isolates from 234 collections. Race 7 (combined with 12) comprised 54 percent of the isolates; race 8 (with 10), 26 percent; race 2 (with 5), 14 percent;

¹ Paper No. 4107, Scientific Journal Series, Minnesota Agricultural Experiment Station. Cooperative investigations with the United States Department of Agriculture.

² For summaries for the years 1939 through 1942, see 522 and 522A to C in the Bureau of Entomology and Plant Quarantine E-series; for 1943, 1944, 1945-49, and subsequent reports through 1953, see unnumbered publications in the Physiologic Races series; for 1954, see ARS-81-3; for 1955, 1956, and 1957, see Plant Disease Reporter, Supplements 239 and 245 and Volume 42, No. 7.

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E. C. Stakman continued leadership in the search for supplemental differential varieties and assisted in race identification at various times. Acknowledgment for collections is made to Donald G. Fletcher and E. B. Hayden, of the Rust Prevention Association, and to personnel of the two Agricultural Research Service Divisions and of the State Colleges and Departments of Agriculture.

⁶ A race comprises many subraces that may be distinguished from each other by different infection types on the standard differentials and/or supplemental varieties. The term "biotype" is restricted to cultures derived from single urediospores or aeciospores which may or may not be the same genotype as a subrace.

⁷ "Race group" is a term applied to closely related races that can be distinguished from each other only under certain environmental conditions.

subrace 7A, about 5 percent; and race 6, 1 percent. Race 8 was identified for the first time from California collections on the varieties Indio and Ventura.

From 29 barberry collections, 16 races and subraces of wheat stem rust were identified among 43 isolates. Race 11, the 17-29 group, and race 24 occurred most frequently. From four barberry collections made in New York, race 2 of oat stem rust was isolated once and race 7 three times.

WHEAT STEM RUST

From 566 collections of rusted wheat, barley, and grasses, 27 races and subraces, or biotypes⁶, of *P. graminis* var. *tritici* were identified among 775 isolates (Table 1). Races 56, 11, 15B, the 17-29 race group, and race 38 were more prevalent than other races and comprised 91 percent of the total isolates identified. Race 56 comprised 29 percent; 11, 23 percent; 15B, 18 percent; the 17-29 group (with race 29), 16 percent; and 38, 5 percent. The remaining 9 percent included 21 other races and subraces (Table 1).

Race 56 decreased slightly in prevalence in 1958 and occurred mainly on winter wheats, barleys, and wild grasses. Most of the late fall collections from Kansas, Oklahoma, and Texas also were race 56, an indication of its survivability. Percentage prevalence of this and other prevalent races in various areas of the United States is given in Table 2.

Race 11 was the most widely distributed race, as it was collected in 26 of 28 States sampled. Its high prevalence in 1958 compared with that in 1957, however, is not representative of regions east of the Rocky Mountains, as it was identified in about 79 percent of the unusually large number of isolates from the Inland Empire of the Pacific Northwest, where stem rust was epidemic. Outside of the Inland Empire it was much less prevalent. Race 11 was identified also from four counties in northern California, where there was rust damage in certain sections at elevations above 4000 feet, according to C. A. Suneson.

Race 15B, which has been decreasing in prevalence since the high of 63 percent in 1953, comprised only 18 percent of the isolates in 1958 compared with 32 percent the previous year (Fig. 1). However, it constituted 45 percent of the isolates from the spring-wheat States (Minnesota, South Dakota, and North Dakota) (Table 2). This race was not found in the Inland Empire or in other States west of Wyoming.

FIGURE 1. Relative prevalence of *Puccinia graminis* var. *tritici* race 15B in the United States, 1950-1958

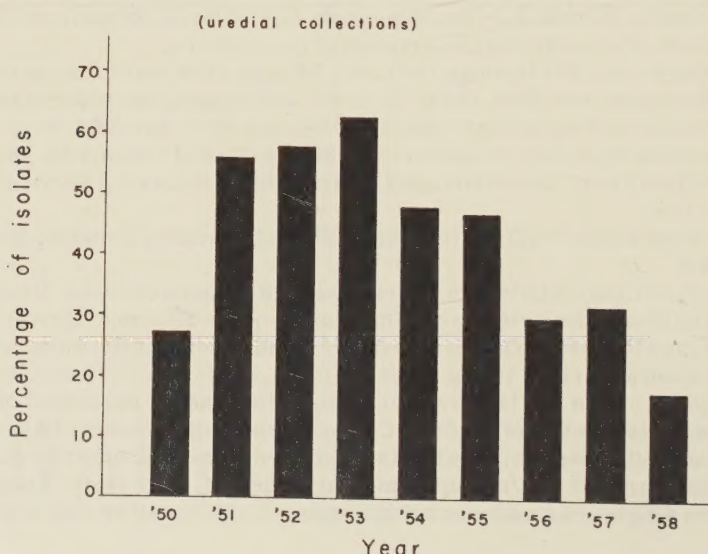


Table 1. Physiologic races of *Puccinia graminis* var. *tritici* isolated from uredial collections in the United States in 1958.

State	Race and number of times isolated																											Total number of--		
	1	10	11	14	15	15B	17-	23	24	27	29	32	34	36	38	46A	46B	49	54	56	59	69	111	133	139	147	186	Isolates	Races	Collections
Alabama	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2
California	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	4
Colorado	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	3	1	3
Florida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1	1
Georgia	-	-	1	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-	6	5	5
Idaho	-	-	35a	-	-	-	1	-	-	-	-	1	-	1	-	-	3	-	-	4	-	-	-	-	-	-	-	45	6	39
Illinois	-	-	7	-	-	6	22	-	-	-	1	-	-	-	6	-	-	-	-	8	-	-	-	-	-	-	-	50	6	36
Indiana	-	-	8	-	-	4	8	-	-	-	3	-	-	-	1	-	-	-	-	9	-	-	-	-	-	-	-	33	6	19
Iowa	-	-	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	20	3	16
Kansas	-	-	4	-	-	15	2	-	-	-	-	-	1	-	1	-	-	-	-	41	-	-	-	-	-	-	-	64	6	43
Kentucky	-	-	4	-	2	3	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	4	11
Michigan	-	-	6	-	1	7	22	-	-	-	3	-	-	5	2	1	-	-	-	11	-	-	-	-	-	-	-	58	9	33
Minnesota	-	-	7	-	4	25	2	-	-	-	-	-	1	-	-	-	-	-	-	18	-	-	-	-	-	-	-	57	6	44
Missouri	-	-	5	-	-	3	3	-	-	-	1	-	-	-	3	-	-	-	-	19	-	-	-	-	-	1	-	35	7	25
Montana	-	-	2a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2
Nebraska	-	-	1	-	-	2	2	-	-	-	-	-	1	-	-	-	-	-	-	7	-	-	-	-	-	-	-	13	5	9
New York	-	1	1	1	-	-	3	1	-	1	-	-	-	-	1	-	-	-	-	1	10b	1	-	-	1	-	1	23	14	17
North Dakota	-	-	4	-	2	27	1	-	-	-	-	-	1	-	1	-	-	-	-	10	-	-	-	-	-	-	-	46	7	36
Ohio	-	-	1	-	-	2	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	4	3
Oklahoma	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	10	3	8
Oregon	-	-	32	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	35	3	32
Pennsylvania	-	-	1	-	-	-	2	-	-	-	3	1	-	-	10	1	-	-	-	3	-	-	1	-	-	-	-	13	8	9
South Dakota	-	-	4	-	2	24	1	-	-	-	-	-	1	-	-	-	-	-	-	33	-	-	-	-	-	-	-	65	6	48
Texas	-	1	17	-	3	11	25	-	-	-	1	-	-	-	18	6	-	-	-	12	-	-	-	-	-	-	-	94	9	65
Virginia	-	-	2	-	-	1	2	-	-	-	-	-	-	-	10	-	-	-	-	1	2d	-	-	-	-	-	-	9	7	8
Washington	1	-	27	-	-	-	1	-	1	-	-	1	-	-	-	1	1	1	1	4	-	-	-	1	-	-	-	40	11	32
Wisconsin	-	-	1	-	-	2	1	-	-	-	2	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	12	5	7
Wyoming	-	-	2	-	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	8	-	-	-	-	-	-	-	13	5	9
Totals	1	2	181	1	14	138	110	1	1	1	15	3	6	1	39	12	5	1	1	224	12	1	1	1	1	1	1	775	27	566
Percentage of isolates	0.1	23.4	1.8	0.1	17.8	14.2	0.1	0.1	0.1	1.9	0.4	0.1	0.6	5.1	1.7	0.7	0.1	0.7	0.1	1.6	28.9	0.1	0.1	0.1	0.1	0.1	0.1	100.0		

aIncludes 1 isolate of the 11-32 group. bIncludes 2 isolates each of 59A and 59B. cIdentified in 38-48 group. dIncludes 1 isolate of 59A.

Table 2. Regional distribution of the 9 most prevalent races and subraces of *Puccinia graminis* var. *tritici* in the United States in 1958.

Region ^a	Race and percentage of total isolates									
	11	15	15B	17-29 ^b	38	48A	48B	56	59	Other
Inland										
Empire	78.5	-	-	2.5	-	2.5	3.3	6.7	-	6.5
Spring										
wheat	8.9	4.8	45.2	2.4	0.6	-	-	36.3	-	1.8
Hard red										
winter wheat	13.1	1.1	14.2	14.6	8.4	2.3	-	44.4	-	1.9
Soft red										
winter wheat	15.0	0.7	12.9	42.1	8.2	1.4	0.7	19.0	-	0.0
East-										
central	8.9	-	2.2	22.3	6.7	2.2	-	11.1	26.8	19.8
Percentage of total isolates (U.S.)	23.4	1.8	17.8	16.1	5.1	1.7	0.7	28.9	1.6	2.9

^a Inland Empire includes Idaho, Oregon, and Washington.

Spring wheat region includes Minnesota, South Dakota, and North Dakota.

Hard red winter wheat region includes Colorado, Iowa, Kansas, Missouri, Nebraska, Oklahoma, Texas, Wisconsin, and Wyoming.

Soft red winter wheat region includes Illinois, Indiana, Michigan, and Ohio.

East-central region includes New York, Pennsylvania, and Virginia.

^b Includes 17-29 race group and race 29.

There also was a shift in prevalence of lines of 15B, which are identified on certain supplemental differential varieties. Golden Ball, for instance, was susceptible to 70 percent of 138 isolates of 15B studied in 1958, in contrast to 40 percent of the 342 isolates studied in 1957. The lines of 15B to which Golden Ball was susceptible in 1958 are especially virulent on the durum, Ramsey and Towner; and those to which Golden Ball was resistant are virulent on Langdon durum. The fluctuation in prevalence of lines within 15B during the last 3 years, as shown by the reaction of Golden Ball, is given in Table 3.

The 17-29 race group, which comprises races 17, 29, and 37, increased from 9 percent in 1957 to 16 percent in 1958 and was found in 21 of 28 States sampled. It was prevalent in Texas and constituted 42 percent of the isolates from the soft red winter-wheat area (Table 2). The prevalence of this race group in early-spring collections in Mexico and Texas indicates the possibility of this area as a source of rust for Illinois, Indiana, Michigan, and Ohio. The only isolates of this race from the spring-wheat area came from screening varieties in nurseries.

As supplemental differential varieties are becoming increasingly important in detecting new and virulent rust cultures, the following wheats, in addition to the 12 standard differentials, were inoculated with all collections of rust identified in 1958: Lee (C.I. 12488), Bowie (Texas Sel. 3708-22), Selkirk (C.I. 13100), Golden Ball (C. I. 5059), Kenya Farmer (C.I. 12880), Frontana x (Kenya 58-Newthatch) (Line II-50-17) (C.I. 13155). In addition, 22

Table 3. Percentage prevalence of lines of 15B differing in ability to attack Golden Ball.

Year	Total number of isolates	Susceptible	Resistant
1956	302	71	29
1957	342	40	60
1958	138	70	30

supplemental test varieties were inoculated with selected isolates of certain races. Some of these varieties appear to be useful in differentiating biotypes or subraces; other do not. Results will be published separately.

New Virulent Isolates

A culture of race 34 which can attack both seedlings and adult plants of Selkirk at moderate temperature (75° F) was isolated from adult Selkirk plants in the nursery at St. Paul. Although this race was identified only six times in 1958 -- once each from Minnesota, North Dakota, South Dakota, Nebraska, Kansas, and Wyoming -- it has potential virulence for Selkirk, which now occupies about 85 percent of the bread-wheat acreage in Minnesota, South Dakota, and North Dakota.

A culture of subrace 48A isolated from a field collection of rusted wheat near Manns Choice, Pennsylvania can attack seedling plants of certain lines of the variety Frontana x (K58-Newthatch), heretofore known as one of the most resistant wheats in the International Stem Rust Nurseries. Seven lines of this variety⁸ were inoculated with the variant of 48A at 65°, 75°, and 85° F. Approximately half the plants of lines II-50-17 and II-50-25 -- the only widely grown lines -- were susceptible; and nearly all plants of line II-50-32 were susceptible. The other four lines, II-50-16, 21, 29, and 35, were immune or showed only necrotic flecks. No differences in rust reaction were evident at the three temperatures.

A culture of race 15 was isolated from durum St. 464 in the St. Paul nursery to which seedlings of line II-50-17 of the variety Frontana x (K58-Newthatch) are moderately susceptible (infection types 2 to 3). The six other lines of the variety were highly resistant. Several other cultures of race 15, which can be differentiated on Golden Ball, are able to attack the bread-wheat Willet and durums Ramsey, Langdon, and Yuma.

Cultures of race 15B also were obtained from nursery collections of the varieties CT 231 and ND 140, both of which are used as sources of stem-rust resistance in the spring bread-wheat-breeding program. These isolates will be studied further.

Races in the Inland Empire of the Pacific Northwest

From 10 aecial and 103 uredial collections of wheat stem rust on barberry, grains, and grasses in northeastern Oregon, eastern Washington, and contiguous sections of Idaho, 138 isolates of 15 races or subraces were identified. Race 11 comprised 91 percent of the uredial isolates in Oregon, 78 percent in Idaho, and 68 percent in Washington. This race also was destructive on certain varieties at Creston, British Columbia, according to the Canadian Department of Agriculture⁹. Prevalence of other races in the Inland Empire is shown in Table 2.

The following 6 of the 15 races were not found elsewhere in the United States in 1958: 1, 36, 44, 49, 54, and 133. In previous years, also, various races were identified from the In-

⁸ Seed furnished by E. R. Ausemus.

⁹ Peturson, B., G. J. Green, and D. J. Samborski. 1959. Cereal rusts in Canada in 1958. Canada Dept. Agr. Res. Lab., Winnipeg, Man., Plant Pathology Report 14.

land Empire and not elsewhere. Race 1, for example, was found only in the Inland Empire in 6 of the 20 years preceding 1958.

From 10 aecial collections, 18 isolates were identified, comprising 10 races: race 1, collected three times in Oregon; race 11, which was found in both Oregon and Washington; and races 24, the 17-29 group, 29, 32, 44, 48 and 48A, and 56.

OAT STEM RUST

From 234 collections, 7 races and 1 subrace of *P. graminis* var. *avenae* were identified among 286 isolates (Table 4). For the ninth consecutive year race 7 was predominant, although

Table 4. Physiologic races of *Puccinia graminis* var. *avenae* isolated from uredial collections in the United States in 1958.

State	: Race and number of times isolated								: Total number of --		
	: 2	: 5	: 6	: 7	: 7A	: 8	: 10	: 12	: Iso-	Collec-	
	:	:	:	:	:	:	:	:	lates	Races	tions
California	-	-	-	-	-	3	-	-	3	1	3
Idaho	-	-	-	-	-	1	1	-	2	2	2
Illinois	3	-	-	10	-	1	-	-	14	3	10
Indiana	-	-	-	4	2	2	-	-	8	3	5
Iowa	5	-	1	40	2	4	1	-	53	6	48
Kansas	1	-	-	10	1	1	-	1	14	5	12
Michigan	3	-	-	11	-	8	-	-	22	3	18
Minnesota	7	1	-	28	3	24	-	-	63	5	50
Missouri	1	-	-	1	-	4	-	-	6	3	6
New York	4 ^a	-	1	11 ^b	-	2	-	1	19	5	14
North Dakota	4	-	-	5	1	1	-	-	11	4	8
Pennsylvania	-	-	-	2	-	-	-	-	2	1	2
South Dakota	6	-	-	17	3	15	-	-	41	4	34
Texas	1	-	-	4	1	-	-	-	6	3	5
Virginia	1	1	-	-	-	-	-	-	2	2	2
Washington	-	-	-	1	-	-	-	-	1	1	1
Wisconsin	2	-	1	9	-	7	-	-	19	4	14
Totals	38	2	3	153	13	73	2	2	286	8	234
Percentage of isolates	13.3		1.0		4.5		0.7				
		0.7		53.5		25.6		0.7	100.0		

^a Isolated also from 1 aecial collection.

^b Isolated also from 3 aecial collections.

Table 5. Physiologic races of *Puccinia graminis* var. *tritici* isolated from aecial collections in the United States in 1958.

State	Race and number of times isolated																Total number of	
	1	11	15	29	23	24	29	32	38	44	48	48A	53	56	59	111	Iso- lates	Collec- tions
Idaho	-	-	-	1	-	1	-	-	-	-	1	1	-	-	-	-	4	2
Illinois	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Iowa	-	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	3	2
Montana	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	2	1
New York	-	3	1	2	1	-	-	-	-	-	-	-	-	-	2	1	10	6
Oregon	3	1	-	2	-	2	1	1	-	2	-	-	-	1	-	-	13	8
Pennsylvania	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	3	2
Virginia	-	-	-	1	-	1	-	-	1	-	-	-	1	-	-	-	4	4
Washington	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Wisconsin	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Totals	3	8	3	7	1	4	2	2	2	2	3	1	1	1	2	1	43	16
Percentage of isolates	7.0	18.7	7.0	16.4	2.3	9.4	4.6	4.6	4.6	4.6	7.0	2.3	2.3	2.3	4.6	2.3	100.0	29

it decreased slightly from the previous year. Race 7 (combined with 12) comprised 54 percent of the uredial isolates; race 8 (with 10), 26 percent; race 2 (with 5), 14 percent; subrace 7A, about 5 percent; and race 6, 1 percent. Race 13 and its virulent subrace 13A were not found in 1958, although they were reported in eastern Canada⁹. Compared with 1957 percentages, those for 1958 represent a decrease of 5 percent for race 7 (with 12), an increase of 5 percent for race 8 (with 10), and an increase of 2 percent for race 2 (with 5).

Subrace 7A, which can attack oat varieties, such as Rodney, with the so-called "Canadian type" of stem-rust resistance at both low and high temperatures, decreased in prevalence by about 2 percent in 1958. Distribution was less extensive also: it was found in 7 States, as compared with 11 in 1957.

Race 8 was identified for the first time in California collections in 1958. The oat varieties Indio and Ventura, which have the Richland type of resistance, were severely damaged in the northern part of the State, especially in Lassen, Modoc, Shasta, and Siskiyou Counties¹⁰. Heretofore these varieties were very resistant throughout California.

Race 6 was identified once each from Iowa, Wisconsin, and New York. This is the fourth consecutive year in which this race has been found outside the barberry-infested areas of northeastern United States. It was found once in Missouri in 1955 and again in 1956, twice in Texas and once in Wisconsin in 1957. It now appears that this race may have become established independently of barberry.

The following varieties of oats, in addition to the standard differentials, were inoculated with all collections of rust from which identifications were made in 1958: Rodney (R. L. 2123), Burnett (C. I. 6537), Landhafer x (Mindo x H-J) x Andrew (C. I. 7144 and 7145), Minnesota '53 Ag. 354, Minnesota Selection II-47-11, Clinton² x Ark. 674 (C. I. 6643), and Saia (C. I. 4639).

RUST FROM BARBERRY

Sixteen races and subraces, or biotypes, of wheat stem rust were identified in 29 aecial collections on barberry, a ratio of 1 race to each 1.8 collections (Table 5). In the 43 isolates identified, race 11, the 17-29 group, and race 24 occurred most frequently. The following races were found only on barberry or in barberry-infested areas in 1958: 1, 23, 24, 44, 48, 53, and 111.

Two races of oat stem rust were identified in four aecial collections from New York: race 2, once; race 7, three times.

PLANT PEST CONTROL DIVISION AND CROPS RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, IN COOPERATION WITH THE MINNESOTA AGRICULTURAL EXPERIMENT STATION, ST. PAUL, MINNESOTA

¹⁰ According to C. W. Schaller, Davis, California.